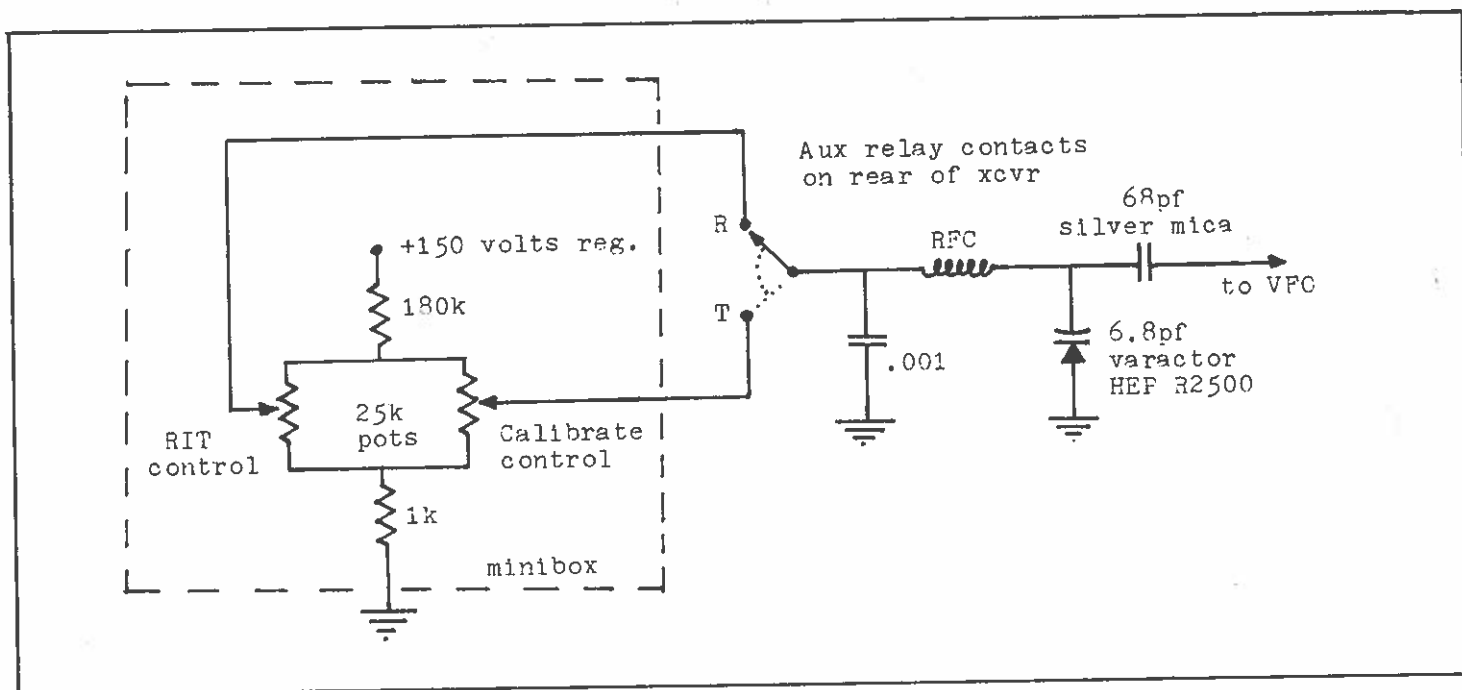




solid-state VFO's) change the 68 pf capacitor to 10 or 15 pf and connect to the output side of the 2N706 oscillator transistor. If you are already using the auxiliary relay to switch a linear, substitute a small 12v DC relay with SPDT contacts to do the job. In that case wire the new relay coil across the aux. relay coil so it will switch when you go from receive to transmit. Radio Shack stocks such small relays. A portion of the components should be mounted in a minibox attached in a convenient position to the side of your rig. The rest should be near the VFO itself.

Once the circuit is connected, it will have to be calibrated. Have a friend listen to his receiver on a pre-assigned frequency. Tune your transceiver to that frequency, then adjust the calibrate control so your transmitted signal is zero-beat on his radio.

This control is now set and should require no more adjustment. The control you use when operating is the RIT control. When your friend transmits, you should be able to tune him with the RIT. (This won't affect your transmit frequency.) John says that he has a 1500 Hz swing on either side of his transmit frequency. The important component in this circuit is the varactor (or varicap) diode. When it is reverse-biased it will exhibit a capacitance proportional to the reverse-bias voltage. This capacitance is part of the tuned circuits in the VFO and thus changes the VFO frequency. Notice that it typically has a very small value of capacitance. For this reason locate the varactor and the three associated components very close to the VFO. Keep their leads short. The wire going to the relay and the parts in the minibox are not as critical. The RF choke (RFC) can be almost anything out of the junkbox. Any small choke should be fine. Remember, if you have any questions or circuits which could be of interest to our readers, be sure to send them in. Thanks to John, W9FZC, for this item.

73, Steve, WA9VNJ

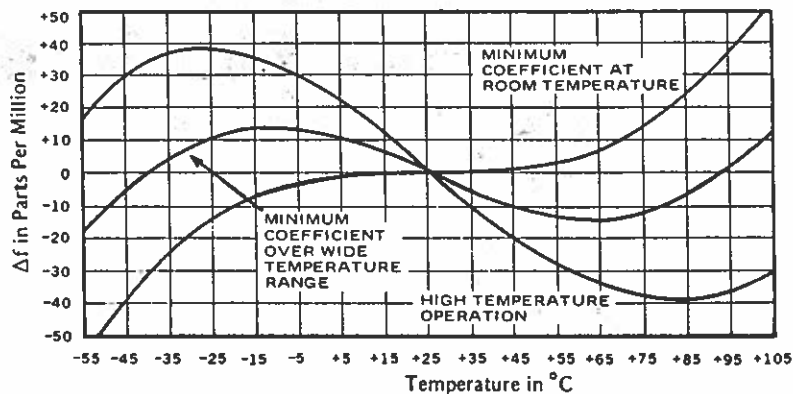
HIGH FREQUENCY OVERTONE CRYSTALS

W9KZO - John Holmbeck

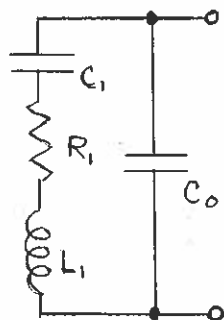
In order to understand overtone crystals, it is first necessary to be aware of some basic concepts and definitions. An overtone is the mechanical equivalent of an electrical harmonic. When a crystal is operated on its overtone, there is practically no energy present at the fundamental frequency. In the case of thickness shear mode crystals such as the AT cuts used at high frequencies, only the odd numbered overtones can be excited because the even numbered ones cancel out. On large low frequency plates it is possible to drive the crystal in either odd or even overtones by proper shaping and location of electrodes. Any crystal, with only two electrodes, can be driven on its odd overtones by appropriate circuitry, and any overtone crystal of this description can be driven on its fundamental.

Contrary to a popular myth, overtone crystals are as stable as fundamental types and from a practical standpoint, can be more so. They have the same set of temperature coefficient curves but with a slight angle difference. For example, either fundamental or overtone crystals can be cut to conform to the same curves. The misconception arises from the results of using a crystal designed for fundamental operation on its overtone. For example, if a fundamental crystal designed for the "high temperature operation" curve is used on its overtone, its curve of frequency versus temperature will be like the one for "minimum coefficient at RT".

Considering a crystal to be used either fundamental or third overtone, C_0 will be the same for either mode.



Since L_1 is the mass of the active part of the quartz blank, it will remain about the same for either mode. Using the formulae shown, if L_1 remains the same, going to three times the fundamental frequency will require that C_1 be reduced by a factor of 9. If you consider C_0 and C_1 as a capacitive voltage divider, it is obvious that the crystal is "decoupled" from the oscillator by a factor of 9. Thus, a given change in input capacity will produce only 1/9 as much frequency change as on that same crystal oscillating on its fundamental and multiplied by 3. On 5th overtone crystals, this factor becomes 25. Of course this also limits the available frequency trim by the same factors.



TYPICAL VALUES
ON ONE CRYSTAL
ON BOTH FUNDAMENTAL
AND THIRD OVERTONE

Inductance is slightly higher
on third overtone because
active area is smaller.

	Freq.	Δf_{20pf} *	R_1	C_0	C_1	C_0/C_1	L	Q
FUND	15.2 MC	7.9 KC	5 ohms	6.2pf	.027pf	227	4 MH	76 K
3rd OT	45.6 MC	1.8 KC	15 ohms	6.2pf	.002pf	2962	5.8 MH	110 K

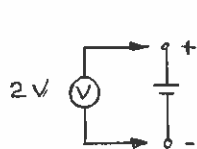
* FREQ DIFF between series resonance and antiresonance with a 20pf load capacity

High frequency overtone crystals require some degree of oscillator tuning to make them operate on the overtone rather than the more closely coupled fundamental. These oscillators fall into three basic types, (1) Pierce, (2) Tuned plate, (3) Series.

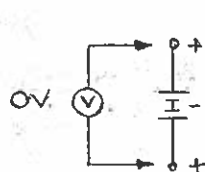
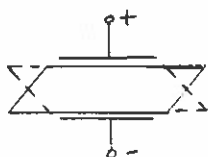
To make a Pierce oscillator drive a crystal on its overtone, it is necessary that the plate circuit tune above the fundamental frequency but below the overtone. On a tuned plate oscillator, the plate must be tuned just above the overtone. A series resonant oscillator is one that is capable of running at the crystal frequency with a small resistance in place of the crystal. It utilizes the series resonant frequency of the crystal which is below the frequency obtained in the other two types.

Overtone crystals are generally more practical for receivers than for transmitters because they are more sensitive to high power levels than fundamental types. As long as a great deal of power gain is required, it may as well include multipliers. The advantage in receivers is primarily freedom from spurious signals as well as simplicity.

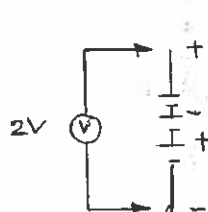
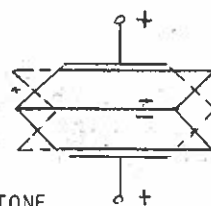
The overtone frequency does not coincide exactly with the harmonic because of "end effects" similar to those on antennas. With electron coupled oscillators, some precautions are necessary if the crystal is to run on the fundamental with the plate tuned to the third harmonic. Under favorable conditions such a circuit can drive the crystal on either frequency, or even both at once. In the latter case, the difference between the overtone and harmonic is also produced, usually resulting in an audible beat. Contrary to much of the data in the FCC tests (at least in the past) the X and Y cuts are no longer used for high frequency control. A modified version of the X-cut is used at low frequencies (under 500KC).



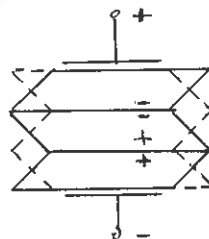
FUNDAMENTAL



SECOND OVERTONE
(No Output)



THIRD OVERTONE
(Two-thirds cancel out)
(One-third left)



Edge view of thickness shear crystal showing nature of motion and its relationship to instantaneous polarity.

Most modern crystals are plated. With extreme drive levels, low frequency crystals can be fractured, but they will change frequency quite drastically first. Plated high frequency crystals seldom shatter. At extreme levels the plated electrode may be burned off, but the quartz will still be intact. They too give ample warning of excess drive by changing frequency. Most CB gear today uses overtone transmitter crystals. In an effort to keep the number of tubes at a minimum, the crystals are run at high drive levels, resulting in severe frequency shifts during the first few seconds of operation. Another frequent symptom of overdrive is "motorboating" on crystals of this type.

In summary, overtone crystals properly used can be more stable than fundamental crystals multiplied to the same frequency. They are limited in trim range and power handling capabilities, but make for simplicity and a minimum of spurious signals being generated. While crystals designed for fundamental operation can be used on their overtones, they will perform poorly compared to crystals designed for overtone operations.

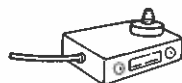
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BODY MOUNT



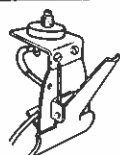
MAGNETIC



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LID



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